ORIGINAL ARTICLE

FORENSIC EVALUATION OF DEATHS DUE TO ACUTE ALCOHOL POISONING IN HYDERABAD

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Background: Acute alcohol poisoning, particularly from methanol ingestion, remains a critical public health issue worldwide. In regions where illicit alcohol production thrives, methanol poisoning cases are prevalent, posing severe risks of mortality and long-term morbidity. Aim and objective was to analyze the forensic profiles of deaths due to acute methanol poisoning in Hyderabad, identifying the main causes and contributing factors to fatalities associated with methanol intoxication. **Methods:** This retrospective descriptive cross-sectional study reviewed 198 autopsy records from a hospital in Hyderabad, focusing on cases identified as methanol intoxication deaths. The study analyzed demographic data, autopsy findings, and toxicological reports. **Results:** A total of 198 fatalities were recorded, with a significant male predominance (91.9%). The age range of the deceased was 21–58 years, with a notable concentration in the 31–40 years age group. High blood methanol concentrations were observed with many cases exceeding the lethal threshold. Autopsy findings highlighted the severe impacts of methanol on the brain, heart, and lungs. **Conclusion:** The study underscores the grave impact of methanol poisoning in the Hyderabad region, with a high rate of fatalities, particularly among young to middle-aged men. It calls for stricter regulation of alcohol production, increased public awareness, and improved medical recognition and treatment of methanol poisoning.

Keywords: Methanol poisoning; Acute alcohol intoxication; Forensic evaluation; Hyderabad; Autopsy report; Toxicological analysis.

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INTRODUCTION

Alcohol dependency increases susceptibility to a diverse array of medical conditions affecting the endocrine system, brain, liver, cardiovascular system, and more, leading to elevated morbidity rates. The 10th revision of the International Classification of Diseases (ICD-10) by the World Health Organization recognizes over 30 alcohol-related health conditions as alcohol use disorders (AUDs), which are the second most prevalent cause of disability among men globally.[1] There is a dose-response relationship between alcohol consumption and health risks, with excessive drinking particularly leading to significant impairments in memory and executive function.[2] The hippocampus is especially sensitive to alcohol's effects, which heightens the risk of mental and neurocognitive difficulties in adolescents and young adults.[3] Alcohol-related mortality is substantial, with an estimated 2.5 million deaths annually, 9% of which occur in individuals aged 15 to 29 years.[4] Data from the Global Burden of Diseases study, encompassing 195 countries from 1990 to 2016 (GBD 2016), underscores alcohol's critical role in contributing to mortality, morbidity, and overall health burden. Notably, alcohol stands as the seventh leading risk factor for death and disability, accounting for 2.2% of deaths in females and 6.8% of deaths in males within the 15–49-year-old demographic. Alcohol is prohibited in Islam for all form of Alcohol in living cases trail will be in Hood Ordinance 1979.

Methanol toxicity is a medical condition that has the potential to damage various organs and can be life-threatening. This condition might present sporadically or in clusters. Incidences of mass poisoning are often observed in nations where high taxation on alcohol leads to the illicit production of alcoholic beverages. Additionally, it can arise from the ingestion of products like perfumes or denatured alcohol among individuals with alcohol dependency, especially when conventional alcoholic (Methanol Poisoning) are on inaccessible**.** The most common mode of methanol entry into the body is through ingestion, but it can also be absorbed through inhalation and, in uncommon cases, through skin contact. Once in the system, methanol distributes

uniformly throughout all body tissues and organs, regardless of how it entered the body.[6,7]

Methanol (CH3OH), a simple aliphatic alcohol, is widely utilized as a solvent and a denaturing additive in various cosmetic products.[8] Its role extends to the synthesis of multiple industrial commodities, including paints, polishes, cleaning agents, and anti-freeze solutions.[9] Exposure to methanol can result in an array of clinical symptoms, ranging from critical metabolic acidosis to irreversible visual impairment, persistent neurologic deficits, and, in extreme cases, fatality.[6,9] In metabolic pathways, methanol undergoes hepatic metabolism to formaldehyde and subsequent oxidation to formic acid. This metabolite, formic acid, exerts toxicological effects on the central nervous system by inducing cellular hypoxia and leading to axonal degeneration.[10]

Methanol's detrimental impact on the central nervous system can be evident following exposure through inhalation, ingestion, or dermal contact.[11,12] Clinically significant indicators such as an anion gap greater than 30 mEq/L, a base excess less than -15 mEq/L, visual impairments, renal dysfunction, and persistent or severe metabolic acidosis (pH below 7.25) necessitate immediate medical intervention, often in the form of haemodialysis, when an individual is exposed to methanol or ethylene glycol.[6,13] The risk of mortality correlates with the degree of metabolic acidosis severity.

The prohibition of alcohol sales to Muslim individuals in Pakistan is enforced due to religious stipulations. Despite this, the illicit consumption of alcohol persists and has been linked to fatal outcomes.[14,15] This research was undertaken to scrutinize the forensic profiles of mortalities attributed to acute alcohol toxicity within the Hyderabad area and its surrounding localities. The objective was to elucidate the predominant causes of fatalities among individuals suffering from acute poisoning

MATERIAL AND METHODS

This study employed a retrospective descriptive cross-sectional methodology to analyze autopsy records from Civil hospital Hyderabad, spanning from January 2021 to December 2022. The focus was on cases where methyl alcohol intoxication was established as the cause of death. Each record encompassed witness testimonies, reports from the crime scene, medical documentation, and comprehensive autopsy findings, including histopathological and toxicological data. A total of 218 fatalities associated with methyl alcohol consumption were initially identified. However, in instances where the only available documentation was the witness statements, a number of 20 cases were deemed ineligible for inclusion due to the absence of corroborating medical or toxicological reports, or post-mortem examinations. Consequently, the study proceeded with an in-depth review of the remaining 198 cases, considering variables such as age, gender, available hospital records, macroscopic and microscopic autopsy findings is not possible to take blood for chemical teats however the decision is on history – macro and microscopic examination, blood methyl alcohol concentrations and any additional chemical evidence, alongside corroborating witness accounts.

RESULTS

Within the specified period, the incidence of methanol poisoning culminated in 198 fatalities. A predominance of the deceased were male, accounting for 182 (91.9%) of the deaths, while female fatalities constituted 16 (8.1%). The deceased individuals' ages spanned from 21 to 58 years. Analyzing the location of these fatalities, it was noted that 42 individuals (21.21%) succumbed in a hospital setting, whereas the majority, 156 (78.79%), were pronounced deceased upon arrival at medical facilities. Of these latter cases, a significant portion, 97 (62.2%), occurred during social gatherings where artisanal alcoholic beverages were consumed. Additionally, 31 individuals (19.87%) were discovered deceased in public areas, 21 (13.46%) in their residences, and 8 (5.13%) at their places of employment.

Age-wise distribution of the cases showed that 32 occurred among individuals aged 21-30 years, 88 within the 31–40 years bracket, 48 among those aged 41-50 years, and 40 cases in the 51-60 years age group. Regarding toxicological data, the concentrations of methanol in the bloodstream of these cases were found to range from 5 to 734 mg per 100 ml.

Among the cohort of 42 hospital admissions, 26 individuals succumbed within the first 24 hours, presenting with blood alcohol concentrations ranging from 50 to 100 mg/dL. The subsequent 16 patients passed away within a period of 2 to 8 days following admission, with detected blood methanol concentrations below 50 mg/dL. The determination of methanol toxicity as the cause of mortality was based on an integration of various evidences, including macroscopic and microscopic analyses from autopsies, clinical observations, and corroborative testimonies. Additionally, blood methanol measurements in a separate group of 156 cases registered levels in excess of 100 mg/dL. Autopsy findings not associated with methyl alcohol poisoning are presented in table below which illustrates the findings from autopsies, categorized by brain, heart, and lung pathologies, with distinctions

made between macroscopic and microscopic observations.

In brain examinations, the most prevalent post-mortem macroscopic finding was general post-mortem changes observed in 92 cases, whereas microscopically, these changes were noted in 62 cases. Cerebral edema was macroscopically evident in 22 cases and microscopically in 14. Hyperaemia was present in 88 cases on macroscopic examination and in 71 cases under microscopic scrutiny. Cerebral haemorrhage was seen in 18 cases macroscopically and in 8 microscopically. Cerebellar haemorrhage, hypothalamic and thalamic haemorrhage, and haemorrhage and necrosis of putamen were less frequent, with cerebellar haemorrhage observed in 7 macroscopic and 5 microscopic examinations, hypothalamic and thalamic haemorrhage only in 5 microscopic cases, and haemorrhage with necrosis of the putamen in 5 macroscopic and 7 microscopic cases. Optic neuritis was not observed macroscopically but was present in 9 microscopic examinations.

Heart pathology findings indicated 104 macroscopic and 88 microscopic cases with post-mortem changes, myocardial ischemia in 2 macroscopic and 7 microscopic cases, and autolysis in 6 macroscopic and 12 microscopic cases. Hypertrophy was equally observed in 26 cases both macroscopically and microscopically, hyperaemia in 78 cases macroscopically and in 72 cases microscopically, and fibrous scarring in 9 cases for both examinations.

Lung pathology showed post-mortem changes in 108 macroscopic and 82 microscopic cases, hyperaemia in 58 macroscopic and 39 microscopic cases, autolysis in 8 macroscopic and 8 microscopic cases, and consolidation in 19 cases both macroscopically and microscopically. Chronic bronchitis and sub-pleural haemorrhage were the least observed, with chronic bronchitis present in 4 cases both macroscopically and microscopically, and sub-pleural haemorrhage in 5 macroscopic and 1 microscopic cases. Bronchiectasis was observed in 5 cases, intra-alveolar haemorrhage was present in 3 cases, and pulmonary congestion was reported in 29 cases.

Liver pathology reports indicated a prevalence of post-mortem changes in 52 cases, while autolytic processes were noted in 6 cases. Fatty changes were documented in 39 instances, and hyperaemia was identified in 51 cases. For the kidneys, post-mortem changes were the most common finding, observed in 88 cases. Parenchymal degeneration was less commonly noted, occurring in 4 cases. Tubular necrosis was evident in 5 cases, autolysis was seen in 6 cases, and hyperaemia was identified in 81 cases. Retention cysts were not observed, while tubular injury was found in 3 cases.

Table-2: Macroscopic and microscopic autopsy findings in study sample

Autopsy Findings	Macroscopic changes (n)	Microscopic changes (n)
Brain		
Post-mortem changes	92	62
Cerebral Oedema	22	14
Hyperaemia	88	71
Cerebral Haemorrhage	18	8
Cerebellar Haemorrhage	7	5
Hypothalamic and Thalamic Haemorrhage	0	5
Haemorrhage and necrosis of putamen	5	7
Optic Neuritis	0	9
Heart		
post-mortem changes	104	88
myocardial ischemia	2	7
Autolysis	6	12
Hypertrophy	26	26
Hyperaemia	78	72
fibrous scarring	9	9
Lungs		
Post-mortem changes	108	82
Hyperaemia	58	39
Autolysis	8	8
Consolidation	19	19
chronic bronchitis	4	4
sub-pleural haemorrhage	8	1
Bronchiectasis	5	5

Autopsy Findings	Macroscopic changes (n)	Microscopic changes (n)
intra-alveolar haemorrhage	3	3
Pulmonary congestion	29	21
Liver		
Post-mortem changes	52	41
Autolysis	6	6
fatty change	39	37
hyperaemia	51	49
Kidney		
Post-mortem changes	88	69
Parenchymal degeneration	4	4
Tubular Necrosis	5	19
Autolysis	6	6
Hyperaemia	81	68
Retention cysts	21	0
tubular injury	3	21

DISCUSSION

Cases of methanol poisoning typically arise from unintended or deliberate ingestion, as well as from the consumption of contaminated beverages in isolated or widespread outbreaks.[14,16,17] The blood concentration of methanol considered to be fatal can be as low as 0.04 grams per decilitre, and the smallest recorded quantity of methanol that has resulted in fatality is 15 millilitres of a solution containing 40% methanol.[18] The presence of methanol in beverages, particularly those produced via amateur distillation practices at home, poses a significant public health concern. Such home distillation processes, often used to create spirits like gin or rum, may increase the concentration of both ethanol and methanol, as these rudimentary methods lack the refinement necessary to effectively separate the two. Studies have indicated that the methanol content in a sample of 20 commercial wines varied from 50 to 325 milligrams per liter[19], and in a selection of 24 distilled spirits, it ranged from 13 to 106 milligrams per liter.[20]

Methanol, a transparent and colourless fluid, is widely utilized in various industrial applications. Its low-cost relative to ethanol makes it a substitute for enhancing the strength of illicitly produced liquors by unauthorized manufacturers. In instances where ethanol is inaccessible, such as in correctional facilities, individuals may resort to using methanol-laced products as replacements for conventional alcoholic drinks. Ingesting a minimal volume of methanol, even as little as 10 millilitres, can lead to irreversible visual impairment, while amounts between 100 and 200 millilitres are potentially lethal. Upon oral consumption, methanol is swiftly absorbed into the gastrointestinal system, with an average half-life for absorption documented at approximately five minutes.[21] The peak levels in the bloodstream typically occur within 30 to 60 minutes, contingent on the co-ingestion of food.[22,23] Methanol has the capacity to remain within the human system for up to a week after intake. Due to its compatibility with water, it is extensively distributed throughout the body's water compartments. This results in higher concentrations in the eye's aqueous and vitreous chambers, the cerebrospinal fluid, and stomach secretions compared to the blood.[24] The distribution volume of methanol is estimated to be in the range of 0.60 to 0.77 litters per kilogram.[21]

The incidence of both isolated and widespread instances of methanol poisoning presents a persistent challenge for experts in forensic medicine globally. Individuals who consume alcohol are sometimes known to intentionally replace ethanol with substances containing methanol, aware of ethanol's detrimental effects. Episodes of such poisonings, ranging from individual cases to major epidemics, have been documented across various regions including India, Kenya, Libya, Turkey, and several other nations as noted in this study.[25–28]

In the current research, the vast majority of deceased individuals were male, accounting for 91.2% (182 cases), while females comprised 8.1% (16 cases), indicating a predominance of male victims. This gender discrepancy aligns with patterns noted in other research, where the frequent consumption of methanol-laden beverages by men has been suggested as an explanatory factor, as posited by Azmak *et al*.[29] Our findings mirror this observation, suggesting a higher habitual intake of methanol among males. The most affected age demographic in our study ranged from 31 to 40 years, representing 88 cases, succeeded by the 41–50-year age bracket with 48 cases. Comparatively, the age distribution in the study by Azmak *et al*. highlighted a similar trend, with the peak of methanol-related deaths occurring between the ages of 41 and 45.[29] These observations underscore

the impact of methanol poisoning as a significant contributor to mortality in the middle-aged population.

Regarding the specifics of methanol toxicity, our study found that blood methanol concentrations varied extensively, from 5 to 734 mg/dL. Notably, 156 cases (78.78%) had concentrations exceeding 100 mg/dL, surpassing the typically cited lethal threshold of 80-100 mg/dL.[30,31] This contrasts with another investigation where postmortem heart blood concentrations following hospital admission due to methanol toxicity were reported to be between 23 to 268 mg/dL.[25,32] The research by Pounder *et al*.[32] and Mittal *et al*.[33] suggests a wide interindividual variability in lethal methanol doses, ranging from 15 to 500 mg/dL. Complementary findings by Karadeniz et al. and Birincioglu *et al*. also revealed a broad spectrum of blood methanol levels, from 15 to 482 mg/dL, with 61.5% of their cases exhibiting concentrations above 100 mg/dL and a portion below 50 mg/dL.[34] Other investigations have similarly reported diverse ranges of methanol blood concentrations, such as 55–479 mg/dL by Azmak *et al*.[29], 50-755 mg/dL by Yayci *et al*.[35], 38-414 mg/dL by Fedakar *et al*.[36], and 350-450 mg/dL by Andersen *et al*.[37], further highlighting the variable nature of this toxicological parameter.

The results of our investigation underscore the necessity for stringent measures to curb the unauthorized manufacture of methanol and denatured spirits. National initiatives to raise awareness about the risks of methanol poisoning are crucial in mitigating fatalities associated with its consumption. Education campaigns detailing the dangers of methanol and its presence in various products should be regularly conducted. The utilization of mass media, particularly television, could significantly amplify the reach of these educational efforts. Additionally, it is imperative to enhance the knowledge base of medical professionals regarding the clinical presentation of methanol poisoning to ensure prompt recognition and appropriate management of affected individuals.

CONCLUSION

This study provides comprehensive forensic profiling of fatalities attributed to acute methanol intoxication in the Hyderabad region, highlighting the severe public health implications of illicit alcohol consumption. Despite efforts to regulate alcohol production and consumption, our findings indicate a high prevalence of methanol poisoning fatalities, predominantly among males aged 21 to 58 years, with a significant portion occurring during social gatherings. The toxicological analysis revealed a wide range of methanol concentrations, underscoring the lethal potential of even small quantities of methanol-laced beverages. This research emphasizes the urgent need for stricter regulations, public awareness campaigns, and improved clinical recognition and management of methanol poisoning to mitigate this preventable cause of mortality.

Study Limitations

Retrospective Nature: The retrospective design may limit the ability to capture all relevant data accurately, including potential underreporting or misclassification of methanol poisoning cases.

Geographic Scope: Findings are specific to the Hyderabad region and may not be generalizable to other areas with different socio-economic conditions and regulatory environments. Case Selection Bias: Exclusion of cases with insufficient documentation may introduce bias, potentially overlooking important patterns or factors contributing to methanol toxicity. Lack of Control Group: The absence of a control group limits the ability to compare risk factors or outcomes directly with those not affected by methanol poisoning.

AUTHORS' CONTRIBUTION

QZP: Literature search, Concept. LR: Data collection, data analysis. SI, SAQ: Concept, literature search, write-up. MHD, HS: Data collection, data analysis, data interpretation.

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